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INFORMAL REPORT

BLAKE RIDGE AEROMAGNETIC SURVEY

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ABSTRACT

Two positive magnetic lineations are revealed in an aeromagnetic survey of a 20,000 square mile area over the Blake Ridge. The two magnetic anomalies are generally parallel to the continental slope, but show no particular relation to the Blake Ridge which they cross at an angle of approximately 70 degrees. The larger of the two anomalies occurs near the edge of the continental shelf in the northwest corner of the survey area. It is believed to be caused by a large body of highly magnetic material injected or extruded along a fracture or crustal adjustment on the seaward edge of a sedimentary trough. The smaller anomaly crosses through the center of the survey area. Computations indicate that it is caused by a susceptibility contrast of 0.010 cgs between a large intrusion of mantle material and the surrounding crustal layers.

This report has been reviewed and is approved for release as an UNCLASSIFIED Informal Report.


Director, Magnetics Division

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I. INTRODUCTION

During April 1957, a special aeromagnetic survey was conducted by the U. S. Naval Oceanographic Office Project MAGNET aircraft NC-54R BUNO 90396. This survey covered an area of approximately 20,000 square miles over a portion of the Blake Ridge in the Atlantic Ocean southeast of Cape Lookout, North Carolina. The location of the survey area is shown in Figure 1.

This report presents and describes the magnetic information collected during that survey together with an interpretation of the possible geologic structure that would account for the observed magnetic field. Bathymetric contours in the area from Hydrographic Office Bathymetric Contour Chart 806N are included for comparison with the magnetic data.

II. SURVEY OPERATIONS

A. Conduct of Survey: Figure 2 shows the aircraft flight lines at their intersection with the total intensity contours. The first flight covered three northeast-southwest oriented base lines. Seven subsequent flights were required to survey 32 northwest-southeast oriented lines spaced 5 miles apart. Continuous recordings of total magnetic intensity data were obtained on all flight lines in the survey area.

Flight altitude during this survey was approximately 1000 feet. Control was maintained primarily by loran-A fixes taken at 15 minute time intervals. The AN/APN-67 Automatic Navigator provided ground speed and drift angle to an accuracy of ± 1 percent. Position accuracy is considered to be within 2 miles.

B. Instrumentation: The Vector Airborne Magnetometer, used in this survey, measures the earth's total magnetic intensity to an absolute accuracy

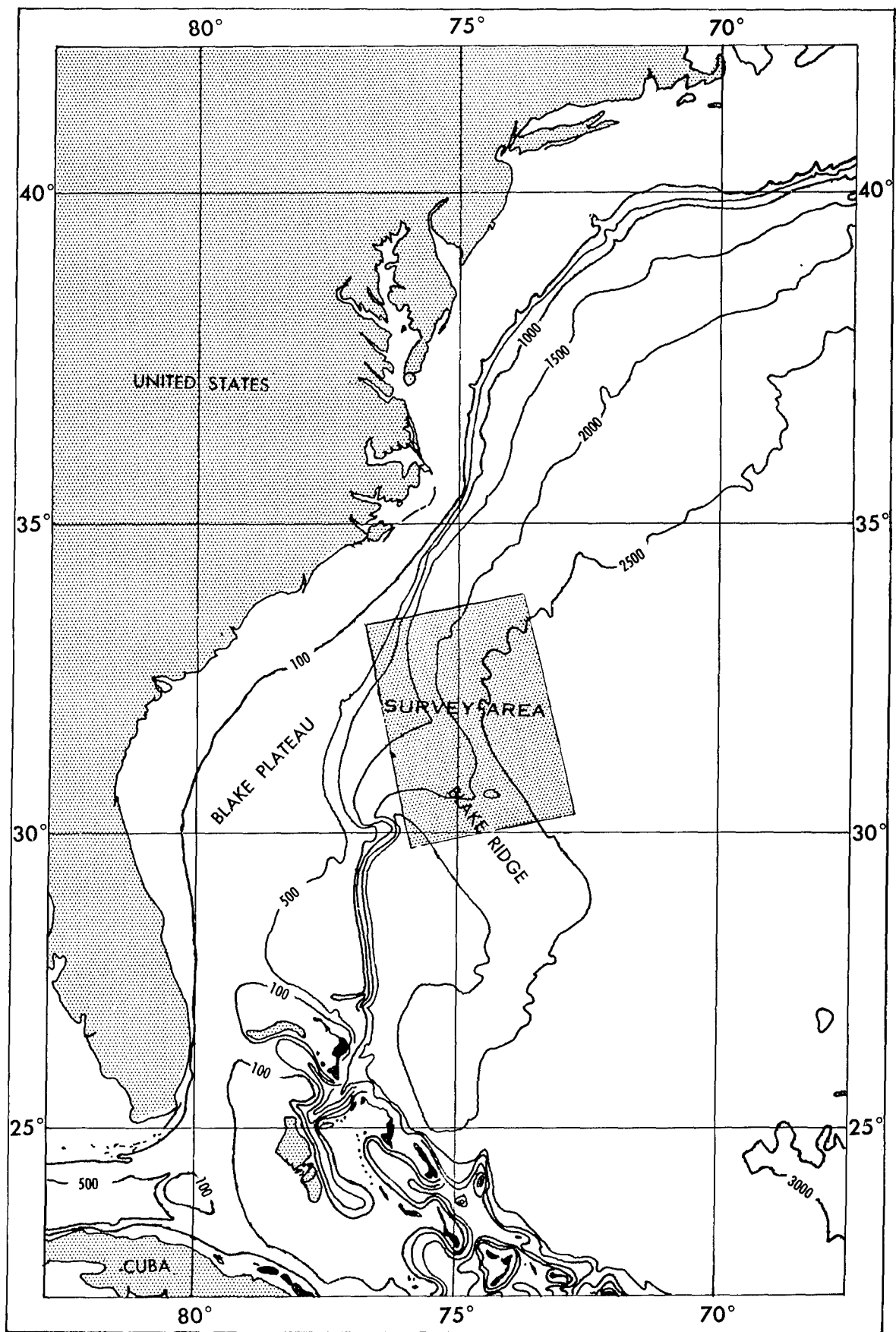


Figure 1. Blake Ridge Survey location chart

of ± 15 gammas and to a relative accuracy of ± 3 gammas. For a description of the instrument, see Schonstedt and Irons [1955].

III. DATA PROCESSING

The total magnetic intensity profiles were reduced to a common datum by applying temporal variation corrections computed from the crossings of the primary survey tracks and the base lines. Figure 2 is a total magnetic intensity contour chart constructed from the corrected values.

A regional magnetic intensity contour chart (Fig. 3) for the survey area was constructed by graphically smoothing the total intensity contours. To amplify the trends of the local magnetic anomalies, the author also prepared the residual magnetic intensity contour chart (Fig. 4) by removing the regional magnetic intensity values from the corrected total intensity values.

IV. SURVEY RESULTS AND DESCRIPTION OF FEATURES

This survey was conducted over what has been described as a transition zone of the continental margin [Heezen et al, 1959]. Figure 5 is a bathymetric contour chart of the area. The Blake Plateau, extending from the southwest, narrows and disappears in the survey area. The most interesting bathymetric feature in the area is the Blake Ridge. This broad feature extending from the base of the continental slope is believed by Hersey et al [1959] to be a possible extension of the Cape Fear Arc (sometimes known as the Great Carolina Ridge or Carolina Ridge). A structure map of the pre-Cretaceous (basement) surface by Woollard et al [1957, p. 64] shows that the arch extends at least beyond the 100 fathom curve.

The magnetic features in the residual chart (Fig. 4) show no particular relation to the Blake Ridge. The principal features are two linear,

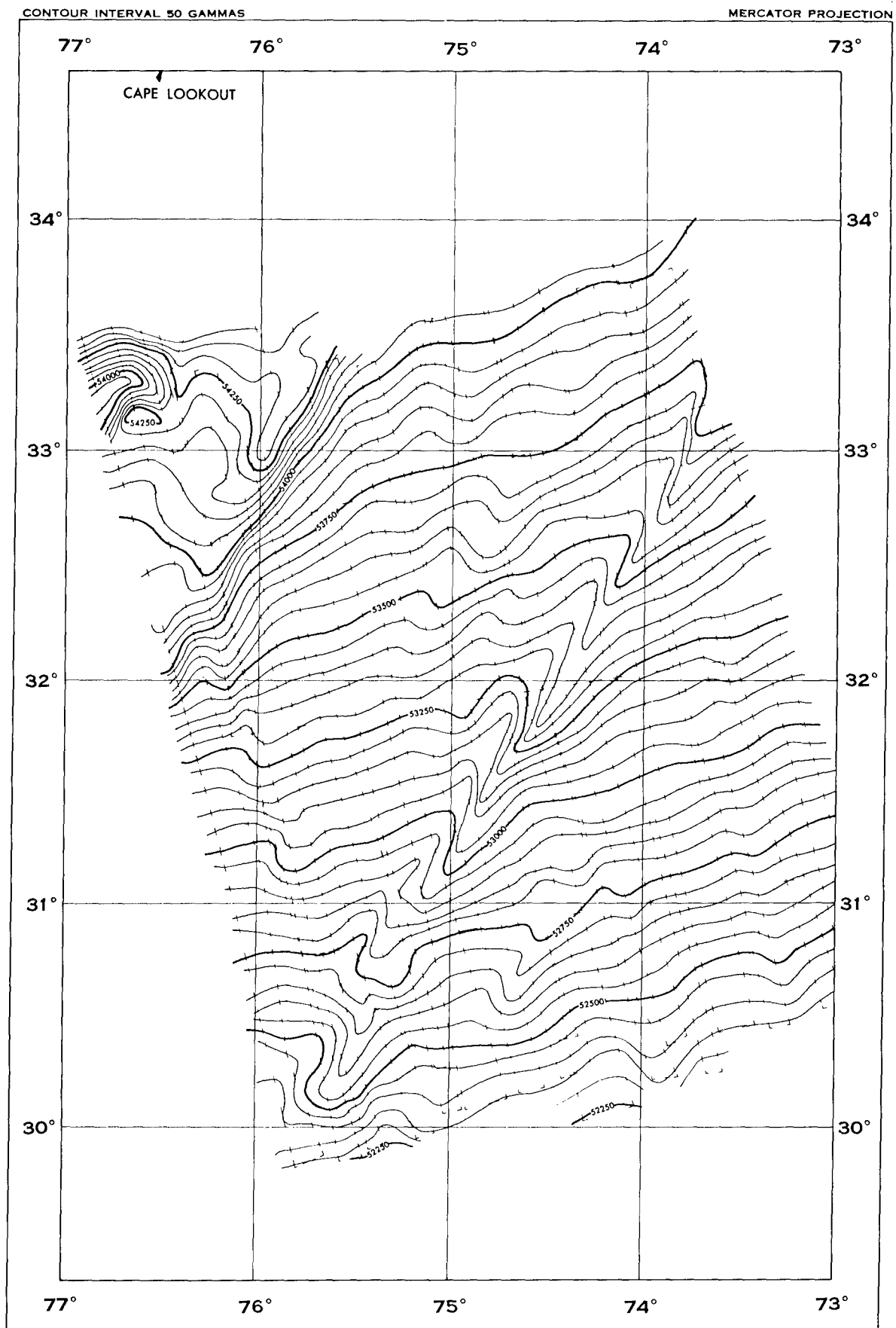


Figure 2. Total magnetic intensity contours and track chart

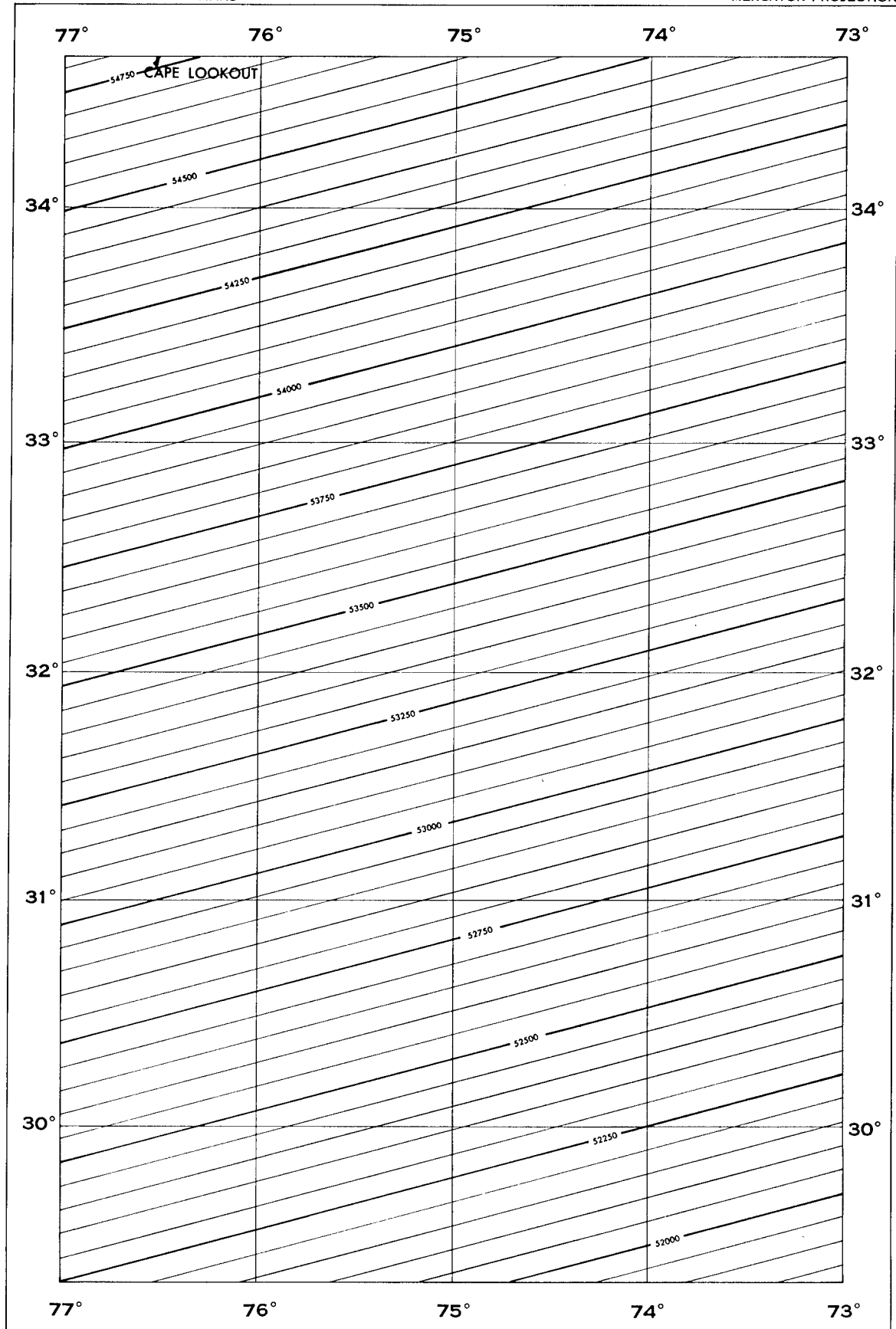


Figure 3. Regional magnetic intensity contours

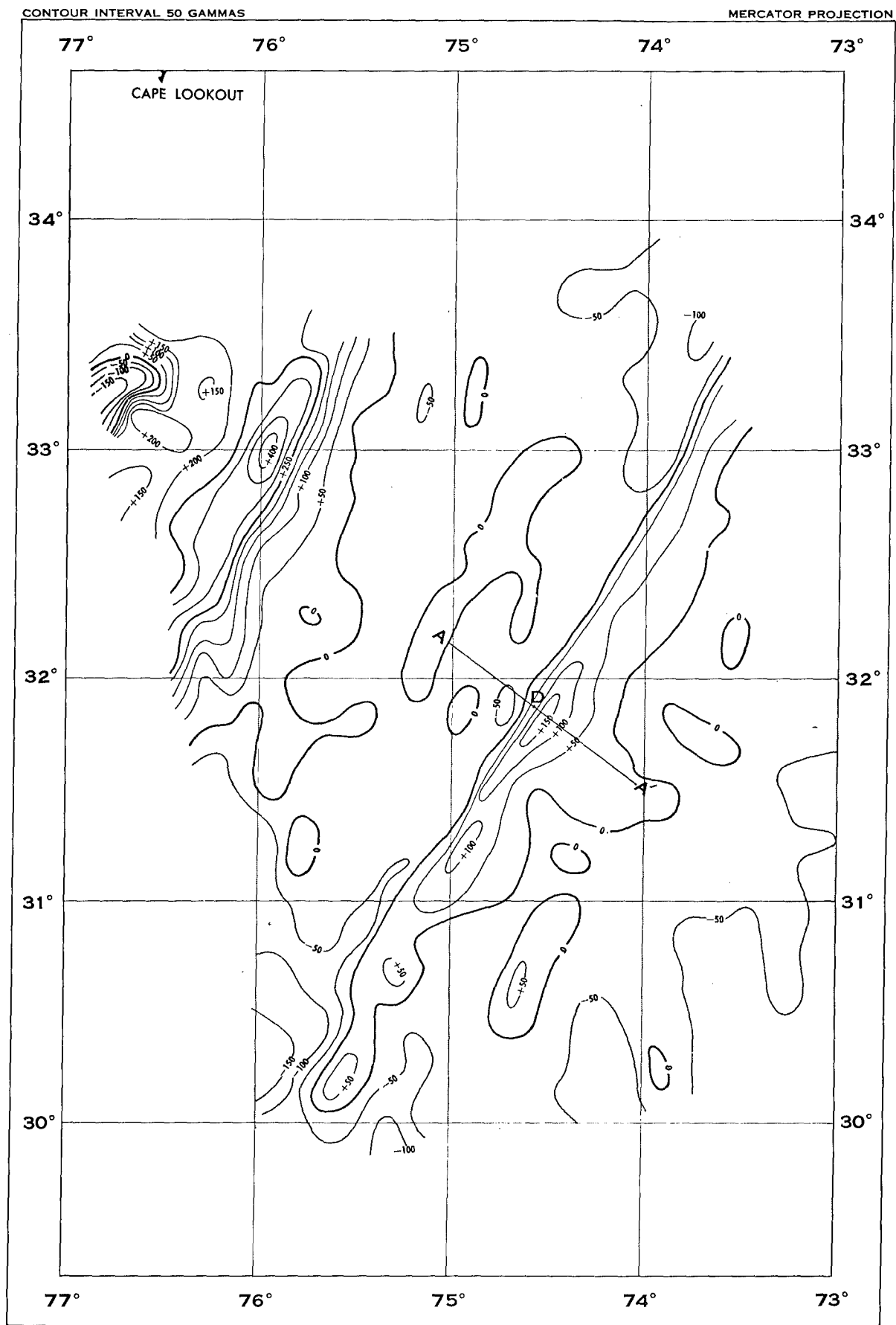


Figure 4. Residual magnetic intensity contours

A sedimentary basin or trough has been postulated near the edge of the continental shelf in this area [Woollard et al, 1957; Hersey et al, 1959; Drake et al, 1963]. It is believed that this magnetic anomaly occurs on the seaward side of the trough, and, as suggested by King et al, 1961, may be caused by a large body of highly magnetic material. This material was perhaps injected or extruded along a break or adjustment deep within the crust at the edge of the trough. The possibility of such a break or adjustment has been suggested by Woollard et al [1957] and Hersey et al [1959].

The long positive anomaly crossing through the center of the survey area has a strike similar to that of the positive anomaly in the northwest section of the area. The amplitude of this anomaly, however, is much lower (150 gammas as opposed to 400 gammas). This anomaly seems to correspond to anomaly 'b' shown by Drake et al [1963, pp. 5261 and 5263]. Empirical depth estimates to the source of this anomaly, using a residual profile drawn along A-A' in Figure 4, indicate that the source is approximately 6 kilometers below the ocean floor.

Seismic work has been done in the south-central part of the survey area by Hersey et al [1959]. Data from this work show a rather abrupt change in seismic velocities from northwest to southeast across this portion of the area in a layer approximately 6-7 kilometers below sea level and extending downward for 3-4 kilometers. Velocities at this depth change from an average value of 3.9 km/sec on the northwestern side of the anomaly to an average value of 5.3 km/sec over the anomaly. This change in seismic velocity probably represents a change in crustal composition in this area, and the compositional change must cause a magnetic susceptibility contrast. The magnetic anomaly across the center of the survey area is believed to be the result of that contrast.

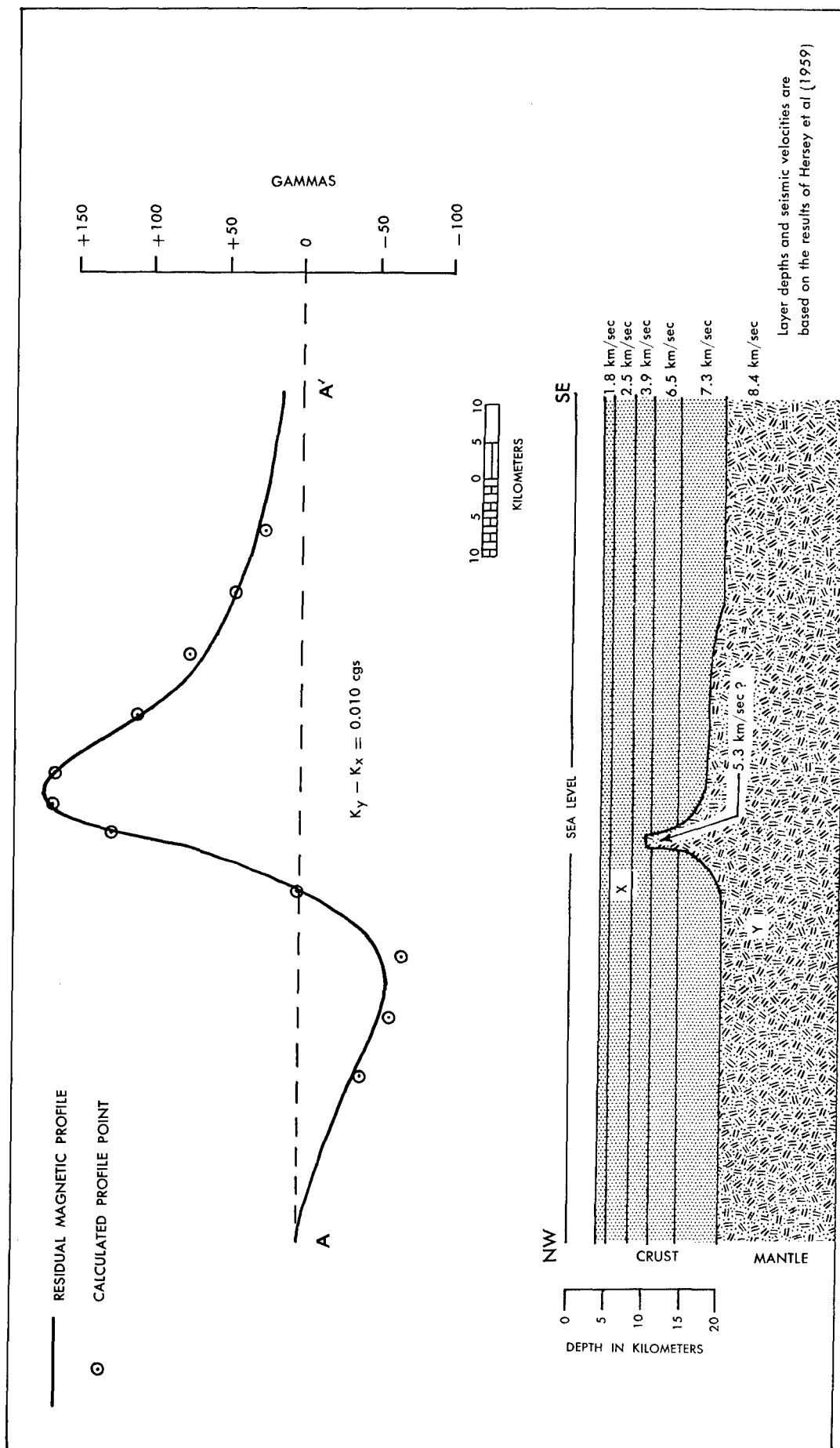


Figure 6. Residual and calculated magnetic profiles A—A' over a model of the inferred suboceanic structure

Figure 6 shows the residual anomaly (solid line) from section A-A' of Figure 4, and points calculated using the method described by Pirson [1940]. In this case it was assumed that the crustal layers and the mantle (X and Y respectively in Figure 6) were each uniformly magnetized and the magnetization was induced in the same direction as the present earth's field. The length of the body along the strike of the magnetic anomaly is assumed to be infinite. Used in the calculations were: a projected magnetic inclination of 73° , a strike of 45° relative to magnetic north, a total intensity base value of 53,250 gammas, and a susceptibility contrast of 0.010 cgs between the crustal and mantle material.

The anomaly indicated by the calculated points in Figure 6 is considered to be a close fit to the residual anomaly. It should be recognized that this solution is not necessarily unique. Other model bodies of differing configurations, depths, etc. could give the same solution. The upper part of the body shown in section A-A', however, is based on the seismic results of Hersey et al [1959] in this area. The lower part of the body is based on the assumption that an intrusion whose upper surface is 6 kilometers deep would have to have a very deep source.

Considering the fit of the calculated anomaly and the seismic evidence, it is concluded that the magnetic anomaly is caused by a susceptibility contrast of 0.010 cgs between a large linear intrusion of mantle material and the surrounding crustal layers. The intrusion has a relief of approximately 11 kilometers, the sides sloping rather gradually upward on the northwest for 4 kilometers and then becoming much steeper as they continue up to the 1.5 kilometer wide crest at 9 kilometers below sea level. The southeastern side of the intrusion is less steep, and near the base,

shows a broad rise of approximately 2 kilometers relief on the surface of the mantle. This rise is indicated on Figure 4 by a 'nosing' of the positive magnetic anomaly toward the southeast along the line A-A'. As can be seen by the limited areal extent of the anomaly, this rise is a local feature of the intrusion. It is probably that the relief of the intrusion varies along its strike. Figure 4 shows that profile A-A' crosses the peak of the magnetic anomaly, which would correspond to the point of maximum relief of the intrusive body.

Hersey et al [1959] mention the possibility of a fault occurring on two seismic profiles which cross the southern end of the magnetic anomaly. It seems likely that the emplacement of a mass of this size, if it did not utilize an already existing fracture system, would cause large scale fracturing of the earth's crust. It is interesting to note that if the linear anomaly described above was extended to the southwest, it would fall along the steep bathymetric escarpment in the southwest corner of the area shown in Figure 5.

The relatively low seismic velocities (5.3 km/sec) found at a depth that would correspond to the crest of the intrusion are difficult to reconcile with the velocities found in true mantle material (8.1 km/sec). It is believed that this difference is caused by changes in the physical properties of the material as it rose from a depth of 20 kilometers below sea level to 9 kilometers below sea level, resulting in a decrease in density near the surface. This process may have been similar to that suggested by Belousov [1960, p. 4132].

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